

# Lung Cancer: An Overview: Epidemiology, Pathophysiology, Diagnosis & Treatment

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## ABSTRACT

Lung cancer remains one of the most common and deadly malignancies worldwide, with its prognosis largely dependent on the stage at diagnosis and the tumour's molecular profile. Despite advances in imaging, biopsy techniques, and therapeutic options, overall survival rates continue to be disappointing. Key risk factors include long-term tobacco smoking, environmental exposures (such as air pollution and radon), and genetic predispositions. From a classification standpoint, lung cancers are broadly divided into non-small cell lung cancer (NSCLC) and small cell lung cancer (SCLC), the former accounting for the majority of cases and being further sub-typed into adenocarcinoma, squamous cell carcinoma and large-cell carcinoma. Recent years have seen significant progress in molecular characterisation — for example, actionable mutations in EGFR, ALK, ROS1 and others in NSCLC — which has enabled targeted therapies and immunotherapies to become part of standard care. Early detection through screening (such as low-dose CT) and delivering personalised treatment based on tumour biology are key strategies to improve outcomes. Nevertheless, major challenges remain: many patients still present at an advanced stage, access to advanced diagnostics and therapies is uneven globally, and treatment resistance often develops. Looking ahead, innovations in biomarkers, artificial intelligence for imaging and risk-stratification, and global efforts to improve equitable care offer hope for better management of lung cancer.

**Keywords:** Genetics; Lung Cancer; Pathogenesis; Treatment

## INTRODUCTION

- What is lung cancer?
- Lung cancer is a malignancy that begins in the lung tissue (bronchi, alveoli, etc.) and has the ability to spread (metastasize) to other organs.
- There are two broad types:
  - Non-Small Cell Lung Cancer (NSCLC) — the more common form, accounting for roughly 85% of cases.
  - Small Cell Lung Cancer (SCLC) — less common but typically more aggressive.
- Why the distinction matters: the subtype affects how the disease behaves, how fast it progresses, and what treatments can work.

### Epidemiology & risk factors

- Epidemiology:
  - Globally, lung cancer remains the leading cause of cancer-related deaths.

- It's highly variable region to region depending on smoking prevalence, pollution, occupational exposures, etc.
- Major risk factors:
  - Smoking (active, long-term): This remains the biggest risk factor.
  - Environmental/occupational exposures: E.g., asbestos, radon, air pollution, indoor biomass fuels.
  - Genetic susceptibility: Some individuals have higher predisposition.
  - Others: Diet, radiation exposure, prior lung disease.
  - An important point: not all lung cancers occur in smokers. Environmental and non-smoking related lung cancers are increasingly recognised.

### Pathophysiology & sub-types

Lung cancer develops when lung cells undergo genetic mutations and start uncontrolled proliferation, evade apoptosis, invade local structures, and potentially metastasize.

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- Sub-typing is critical because different molecular pathways are involved and different treatments apply:
- Within NSCLC: adenocarcinoma, squamous cell carcinoma, large cell carcinoma.
- Molecular biomarkers: EGFR mutations, ALK rearrangements, ROS1 fusions etc in subsets of patients.

### Diagnosis & staging

Patients may present with symptoms like persistent cough, chest pain, haemoptysis (coughing up blood), shortness of breath. But many are diagnosed late because early-stage disease may be asymptomatic.

- Imaging (chest X-ray, CT scan) → PET scan → biopsy (bronchoscopy/needle) for histology & molecular testing.
- Staging:
- Based on how far the disease has spread (tumour size, lymph node involvement, metastases). The stage at diagnosis profoundly influences prognosis.
- Example: If diagnosed at Stage I (early) the 5-year survival may be 50–70%, whereas Stage IV (metastatic) might be only 1–5%.

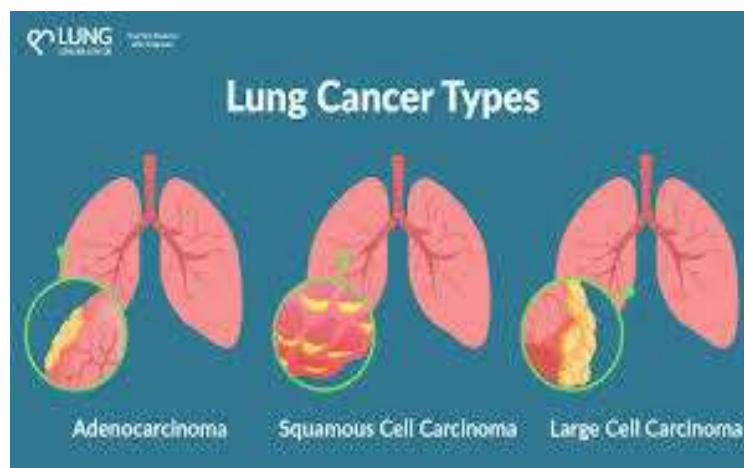
### Screening:

- In some countries, low-dose CT screening is used among high-risk (e.g., heavy smokers) populations. Such screening helps detect earlier stage disease which is more treatable.
- However, screening has limitations (false positives, cost, resource requirements) and is less available everywhere.

### Prognosis & Outcomes

Prognosis depends heavily on stage at diagnosis: early detection → much better outcomes; advanced spread → much worse.

- Historically, lung cancer survival rates have been low compared with many other cancers. For example: in metastatic disease the 5-year survival may be in single digits.
- However, improvements have been seen: thanks to better therapies, earlier detection, molecular targeting. One review noted: “survival among lung cancer patients was significantly improved compared with historical controls, turning lung cancer from an incurable disease into a chronic disease” in many settings.
- Despite progress, lung cancer remains a major burden globally.



### Classification of lung cancer

Lung cancers are broadly classified into two types:

#### Small cell lung cancers (SCLC)

#### Non-small cell lung cancers (NSCLC)

Small cell lung cancer (SCLC): It is one of the most aggressive and rapidly growing lung cancers

comprising 20% of all lung cancers. This type of cancer is strongly related to cigarette smoking. SCLC often metastasizes rapidly to many sites and is discovered during late stages. These cancers have a specific cell appearance under the microscope, the cells being smaller than the cells of Non-Small Cell lung Cancer. SCLC often remains central to the lung and grows along the wall of large bronchus. The cells multiply quickly and form large tumors that spread

throughout the body. Non-small cell lung cancer (NSCLC): It is the most common type of lung cancers and accounts for about 80% of all lung cancers. NSCLC can be divided into three main types: Adenocarcinomas: This is found in the gland of the lung that produces mucous and is the most common type of NSCLC in Women and nonsmokers Adenocarcinomas comprise up to 50 % of NonSmall Cell Lung cancers and it arises in the outer, or peripheral, areas of the lung. A subtype of it is Bronchioloalveolar Carcinoma that develops frequently at multiple sites in the lungs and spreads along the preexisting alveolar walls Sometimes adenocarcinomas arise around a scar tissue and are associated with asbestos exposure.

**Squamous Cell Carcinomas:** These are also known as epidermoid carcinomas and accounts for about 30-40% of primary lung tumors. This type of cancer grows commonly in the central areas around major bronchi in a stratified or pseudoductal arrangement. The cells have an epithelial pearl formation with individual cell keratinization.

**Large Cell Carcinomas:** The tumor cells are large and show no other specific morphological traits. Sometimes they are referred to as undifferentiated carcinomas, and they are the least common type of Non-Small Cell Lung Cancer. The prognosis and treatment options depend on how widespread the disease is when diagnosed. The TNM classification system is used to subgroup the patients according to the extent of the disease. The method classifies patients based on the size of primary tumor (T), degree of spread to lymph nodes (N) or distant spread at the time of surgery (M). TNM classification is crucial for further treatment options and must be present before treatment is initiated.

**T-stage** This stage considers mainly the size of the primary tumor. From TX (positive cytology, but unknown tumor) and T0 (not detected primary tumor) to T3 (tumor > 7 cm) and T4 (tumor invading surrounding organ areas).

**N-stage** o NX - Regional lymph nodes cannot be assessed o N0 - no lymph node metastases o N1 – The cancer has spread to lymph nodes within the lung and/or around the area where the bronchus enters the lung (hilar lymph nodes) Metastasis to lymph nodes

is on the same side as the primary tumor. o N2 – The cancer has spread to lymph nodes around the carina (point where the windpipe splits into the left and right bronchi) or in the space behind the breast bone and in front of the heart (mediastinum. Metastasis to mediastinal nodes is on the same side as the primary tumor. [24] o N3 - Metastasis to nodes on the opposite side of the lungs.

**M-stage** o MX - distant spread cannot be assessed o M0 - no distant metastases o M1 - distant metastases o M1a - distant spread to the lung on the opposite side of the main tumor. M1b - distant metastases.

### Symptoms related to the primary tumor:

The growth and invasion of cancer in the lung tissues and other surrounding areas may interfere with breathing that leads to some symptoms such as Cough, o Shortness of breath, o Wheezing, o Chest pain o Coughing up blood (hemoptysis). o In case the cancer has invaded nerves it may cause o Shoulder pain that travels down the arm (Pan Coast's syndrome) paralysis of the vocal cords leading to hoarseness. If it invades to esophagus o It may cause difficulty in swallowing (dysphasia).

### Symptoms related to metastasis:

If the lung cancer has spread to bones o It may cause excruciating pain in the bones. o In case of spreading to bones it causes number of neurologic symptoms that may include blurred vision, headaches, seizures, or, symptoms of stroke such as weakness or loss of sensation in parts of the body.

**Paraneoplastic symptoms:** Most frequently lung cancers are accompanied by symptoms that result from production of hormone-like substances by the tumor cells. o the paraneoplastic syndromes occur most commonly with SCLC but in some cases, it may also be seen with some other type of tumor. o A release of parathyroid hormone like substance is the most frequent paraneoplastic syndrome seen with NSCLC. The release of this substance leads to elevated levels of calcium in the blood stream.

**Nonspecific symptoms:** Some nonspecific symptoms may be seen in lung cancer Such as o Weight loss, o Weakness, o Fatigue. o Other psychological

symptoms like depression and mood changes are also common.

**No symptoms:** In around 25 % of patients with lung cancer the disease is discovered on a routine chest X-ray or CT scan as a solitary mass (coin lesion). Some of these patients with small, single masses show up no symptoms at the time cancer is discovered.

### **Radiation:**

The term for the treatment of cancer with xrays. It works by killing cancer cells and often used on its own to treat lung cancer. It may also be given as part of a combined treatment with surgery and/or chemotherapy. It is usually given from outside the chest (external radiotherapy) by directing x-rays at the area needing treatment. The machines that are most commonly used for this are called linear accelerators. However, radiotherapy can also be given by putting a small amount of radiation directly inside the lung (brachytherapy).

### **Chemotherapy and radiotherapy**

Giving chemotherapy before or after radiotherapy can sometimes help to get rid of early stage NSCLC in people who can't have surgery. The chemotherapy drugs will usually be the same as mentioned above. These treatments can also help some people with advanced non-small cell lung cancer to live longer even if they are not likely to be cured of their cancer. If you are fairly fit, your doctor may suggest combined treatment with radiotherapy and chemotherapy (chemoradiation).

### **Chemotherapy for non-small cell lung cancer**

Chemotherapy to treat non-small cell lung cancer in the following situations After surgery for early-stage cancer Before, after, or alongside radiotherapy treatment for locally advanced lung cancer or cancer that has spread Chemotherapy after surgery for early-stage NSCLC, chemotherapy after surgery can help to lower the risk of the cancer coming back. Combinations of chemotherapy tend to work better than single drugs. Usually combine cisplatin or carboplatin (Paraplatin) with at least one other drug such as Vinorelbine Gemcitabine Paclitaxel (Taxol)

Docetaxel (Taxotere) Doxorubicin Etoposide Pemetrexed.

### **Future Directions**

- Better screening & early detection: Including improved imaging, biomarkers (blood tests, etc), AI-assisted detection.
- Expanding targeted therapies: Identifying more actionable mutations and tailoring therapies even more precisely.
- Combining therapies: Immunotherapy + targeted therapy + conventional treatments might improve outcomes.
- Preventative strategies: Stronger tobacco control, reducing indoor/outdoor air pollution, occupational safeguards.
- Personalised/precision medicine: Using genomics, transcriptomics, proteomics to tailor treatments further.
- Global health equity: Making sure advances reach lower income countries, or resource-limited regions.
- AI & digital health integration: Data & AI tools to help diagnosis, decision support, prognostication.

### **What Does This Mean for Patients (and Families)**

- If lung cancer is detected early, the outlook is significantly better — which emphasises the importance of screening (where appropriate) and being alert to symptoms.
- Know the subtype/molecular profile: In NSCLC, testing for EGFR/ALK/ROS1 etc may open access to more effective targeted treatments.
- Lifestyle matters: Smoking cessation, avoiding harmful exposures (pollution, occupational hazards), healthy diet and physical activity may help.
- Supportive/palliative care is very important: even when cure isn't possible, quality of life, symptom management, psychological support are critical.
- Ask about clinical trials: With rapid advances, some patients may be eligible for novel therapies/trials.
- Access/cost issues: In many regions (including India) availability of advanced treatments may be limited — it's good to discuss with the care team early about options and cost/benefit.

### **CONCLUSION:**

In this article, we have briefly explained about the Lung Cancer, It is the leading cause of cancer death

and the second most diagnosed cancer in both men and women. Cigarette smoking is the primary cause of lung cancer. Lung cancer also can be caused by using other types of tobacco (such as pipes or cigars), passive smoke, being exposed to substances such as asbestos or radon, and having a family history of lung cancer. Lung cancers typically start in the cells lining the bronchi and parts of the lung such as the bronchioles or alveoli. About 80% to 85% of lung cancers are NSCLC. The main subtypes of NSCLC are adenocarcinoma, squamous cell carcinoma, and large cell carcinoma the only recommended screening test for lung cancer is low-dose computed tomography. Lung cancer is treated in several ways, depending on the type and stage of lung cancer. People with non-small cell lung cancer can be treated with surgery, chemotherapy, radiation therapy, targeted therapy, or a combination of these treatments. People with small cell lung cancer are usually treated with radiation therapy and chemotherapy.

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